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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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If no title is shown please refer to the description.
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Analyzers for transmissive LCD based projectors

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Analyzers for transmissive LCD based projectors

BACKGROUND OF THE INVENTION

Field of the Invention

The present patent application relates to the field of analyzers for transmissive type LCD projection type video image display devices, and particularly to an imaging optical system for a projection type video image display device comprising such analyzers as well as a method for method for arranging such analyzers in the imaging optical system of a projection type video image display device.

Description of the Related Art

Today many transmissive type LCD projection type video image display devices produce limited brightness and have a limited lifetime. One limiting factor has been the use of absorptive analyzers, which have been required to absorb large amounts of light when filtering out light of unwanted polarization. This has among other things led to undesired thermal effects, which have had a negative impact on the lifetime of the devices.

One prior art approach is disclosed in JP 11 295 660, which suggest to enhance reliability against heat generated around a light valve in a transmission projection picture display constituted of the light valve utilizing polarized light. This projection picture display is constituted so that a picture is displayed by regulating random light emitted from a light source to unidirectional polarized light by an incident-side polarizing plate, controlling the polarizing direction thereof for each pixel by the light valve and transmitting the polarized light only in one polarizing direction by an emitting-side polarizing plate, enlarged and projected by a projection lens. Since the emitting-side polarizing plate is a reflection polarizing plate and inclined with respect to the surface of the light valve, heat is suppressed from being generated near the light valve and the emitting-side polarizing plate. Thus, deterioration of reliability is suppressed.

However, this prior art approach has limitations in its ability to provide for a compact design and short back focal length of the projection lens, which will make a projector utilizing this approach fairly large and expensive.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an improved imaging optical system for a projection type video image display devices.

This object is achieved through providing an imaging optical system comprising a refractive analyzer device arranged to pass light of a first polarization mode in an imaging path and cause an angular deviation of light of a second polarization mode with respect to said imaging path, a reflective analyzer device, arranged at a separation distance from said refractive analyzer device along said imaging path, and arranged to pass light of the first polarization mode in said imaging path and reflect deviated light of the second polarization mode out of said imaging path.

Thanks to the provision of the refractive analyzer device before the reflective analyzer device the separation distance required to deviate unwanted light out of said imaging path can be kept low, thereby enabling a compact design where the back focal length of an associated projection lens can be kept short, whereby the production cost of projection type video image display devices can be reduced.

Another object of the invention is to provide an improved method for configuring such analyzers in projection type video image display devices.

This object is achieved through a method comprising the steps of: providing a refractive analyzer device arranged to pass light of a first polarization mode in an imaging path and cause an angular deviation of light of a second polarization mode with respect to said imaging path; providing a reflective analyzer device at a separation distance from said refractive analyzer device along said imaging path, said reflective analyzer being arranged to pass light of the first polarization mode in said imaging path and reflect deviated light of the second polarization mode out of said imaging path.

Still other objects and features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims. It should be further understood that the drawings are not necessarily drawn to scale and that, unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, wherein like reference characters denote similar elements throughout the several views:

Fig. 1 discloses a schematic view of a refractive analyzer;

Fig. 2 discloses a schematic view of a stacked refractive analyzer according to figure 1;

Fig. 3 discloses a schematic view of a first embodiment of an analyzer configuration for a projection type video image display device;

Fig. 4 discloses a schematic view of a second embodiment of an analyzer configuration for a projection type video image display device.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

Fig. 1 is a schematic view showing a basic constitution of a refractive analyzer 1. A uniaxial oriented birefringent layer 2 is sandwiched between two transparent carrier substrates 3. The substrates 3 each have a fine pitch "saw-tooth" structure 4, deposited on their respective inner surfaces. The fine pitch "saw-tooth" structure 4 is preferably made up of layers of polyimide plastic (PI). An incident light beam 5 containing p- and s-polarized light is shown falling on the refractive analyzer 1. The material properties are selected such that the first polarization mode, e.g. the p-polarized light-beam 6, does not observe large variation of refractive indices, and as such observes the refractive analyzer as a plane parallel plate, and is thus passed on along an imaging path. The second polarization direction, e.g. the s-polarized light 7, however, observes a large difference in refractive indices between the materials and is refracted in the interfaces, such that its direction of propagation is changed as the beam passes the refractive analyzer 1, causing an angular deviation with respect to the imaging path. As this refractive analyzer 1 is intended to be arranged in the imaging optical system of a projection type video image display device, the optical demands on imaging properties are very high. However, the differences in refractive indices are usually limited, such that the deviation from the propagation direction usually is limited, and thus use of one such refractive analyzer alone in the optical path of a projection type video image display device is usually insufficient in providing sufficient direction change of the second polarization direction, to cause this second polarization direction to be diverted outside of the imaging path.

Fig. 2 shows a solution for providing increased direction change of the second polarization light 7. This is achieved through stacking two or more of the refractive

analyzers 1 in accordance with figure 1. This way an increased degree of angular splitting can be achieved. The incident light-beam 5, containing p- and s-polarized light falls on the stack of refractive analyzers 1 and the unwanted second polarization direction, e.g. the s-polarized light-beam 7, is deviated stepwise by each layer thereof. The wanted first polarization mode, e.g. the p-polarized light-beam 6, passes straight through the refractive analyzer 1.

Fig. 3 illustrates a first embodiment of a possible analyzer configuration shown in a simplified light path of a projection type video image display device. The shown light path comprises a liquid crystal (LCD) light valve 8, a refractive analyzer 1 in accordance with figure 1, a dichroic prism 9, a reflective analyzer 10 and a projection lens 11. In accordance with this configuration the refractive analyzer 1 is used in combination with a reflective analyzer 10, e.g. a so called Moxtek® plate. The refractive analyzer 1 and the reflective analyzer 10 are positioned at such a separation distance from each other that the dichroic recombination prism 9 fits in-between them. An incident light-beam 5 containing p- and s-polarized light from the LCD light valve 8 falls on the refractive analyzer 1. In this configuration the unwanted second polarization mode, e.g. the s-polarization direction, illustrated by arrows 7, can travel over a larger distance to become separated from the wanted first polarization mode, e.g. the p-polarized light-beam, illustrated by arrow 6. The wanted first polarization mode (p-polarized) light-beam 6 passes through the projection lens 11 to be incident on a screen (not shown) while the unwanted second polarization mode (s-polarized) light-beam is reflected out of the imaging path. Through this configuration the required angular deviation introduced by the refractive analyzer 1 for diverting the unwanted light out of the main light path is reduced, whereby the number of layers of the refractive analyzer 1 can be reduced, preferably to one single layer in accordance with figure 1. However, if required, it is possibly to employ a stack of refractive analyzers 1, in accordance with figure 2, in the first embodiment according to figure 3.

Fig. 4 shows a second embodiment essentially corresponding to the figure 3 embodiment but with the difference that the reflective analyzer 10 is arranged at an angle relative to the imaging path, whereby the deviation of the unwanted beam 7 can be further increased.

In the following will be described a method for arranging analyzers in the imaging optical system of a projection type video image display device. The method comprises the steps of: providing a refractive analyzer device arranged to pass light of a first polarization mode (e.g. p-polarized light) in an imaging path and cause an angular deviation of light of a second polarization mode (e.g. s-polarized light) with respect to the imaging

path; providing a reflective analyzer device at a separation distance from said refractive analyzer device along said imaging path, said reflective analyzer being arranged to pass light of the first polarization mode in the imaging path and reflect deviated light of the second polarization mode out of said imaging path.

In a further embodiment the method further comprises the step of providing a dichroic prism in said imaging path between said refractive analyzer and said reflective analyzer, thus providing said separation distance.

In a yet further embodiment the method comprises the step of providing a refractive analyzer which comprises at least one uniaxial oriented birefringent layer, where each respective birefringent layer is sandwiched between two transparent carrier substrates, each of which has a fine pitch saw tooth structure deposited on their respective sides facing one of said birefringent layers.

In a still further embodiment the method comprises the step of providing a refractive analyzer which comprises two or more uniaxially oriented birefringent layers.

Thus, while there have been shown and described and pointed out fundamental novel features of the invention as applied to a preferred embodiment thereof, it will be understood that various omissions and substitutions and changes in the form and details of the devices illustrated, and in their operation, may be made by those skilled in the art without departing from the spirit of the invention. For example, it is expressly intended that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.

CLAIMS:

1. An imaging optical system for a projection type video image display device comprising: a light source for emitting illumination light, a transmissive liquid crystal light valve (8), a refractive analyzer device (1) arranged to pass light (6) of a first polarization mode in an imaging path and cause an angular deviation of light (7) of a second polarization mode with respect to said imaging path, a reflective analyzer device (10), arranged at a separation distance from said refractive analyzer device (1) along said imaging path, and arranged to pass light (6) of the first polarization mode in said imaging path and reflect deviated light (7) of the second polarization mode out of said imaging path.

2. The imaging optical system of claim 1, further comprising a dichroic prism (9) arranged in said imaging path between said refractive analyzer (1) and said reflective analyzer (10) providing said separation distance.

3. The imaging optical system of claim 1, wherein said refractive analyzer (1) comprises at least one uniaxial oriented birefringent layer (2), where each respective birefringent layer (2) is sandwiched between two transparent carrier substrates (3), each of which has a fine pitch saw tooth structure (4) deposited on their respective sides facing one of said birefringent layers (2).

4. The imaging optical system of claim 3, wherein said refractive analyzer (1) comprises two or more uniaxially oriented birefringent layers (2).

5. A projection type video image display device comprising the imaging optical system of any one of claims 1 to 4.

6. A method for arranging analyzers in the imaging optical system of a projection type video image display device, wherein said method comprises the steps of:

providing a refractive analyzer device arranged to pass light of a first polarization mode in an imaging path and cause an angular deviation of light of a second polarization mode with respect to said imaging path;

providing a reflective analyzer device at a separation distance from said refractive analyzer device along said imaging path, said reflective analyzer being arranged to pass light of the first polarization mode in said imaging path and reflect deviated light of the second polarization mode out of said imaging path.

7. The method of claim 6, further comprising the step of providing a dichroic prism in said imaging path between said refractive analyzer and said reflective analyzer, thus providing said separation distance.

8. The method of claim 6, further comprising the step of providing a refractive analyzer which comprises at least one uniaxial oriented birefringent layer, where each respective birefringent layer is sandwiched between two transparent carrier substrates, each of which has a fine pitch saw tooth structure deposited on their respective sides facing one of said birefringent layers.

9. The method of claim 8, further comprising the step of providing a refractive analyzer which comprises two or more uniaxially oriented birefringent layers.

ABSTRACT:

The present invention relates to an imaging optical system for transmissive type LCD projection type video image display devices comprising analyzers (1, 10) as well as a method for arranging such analyzers (1, 10) in such an imaging optical system. The imaging optical system comprises a light source for emitting illumination light, a transmissive liquid crystal light valve (8), a refractive analyzer device (1) arranged to pass light (6) of a first polarization mode in an imaging path and cause an angular deviation of light (7) of a second polarization mode with respect to said imaging path. The imaging system further comprises a reflective analyzer device (10), arranged at a separation distance from said refractive analyzer device (1) along said imaging path, and arranged to pass light (6) of the first polarization mode in said imaging path and reflect deviated light (7) of the second polarization mode out of said imaging path.

(Fig. 3)

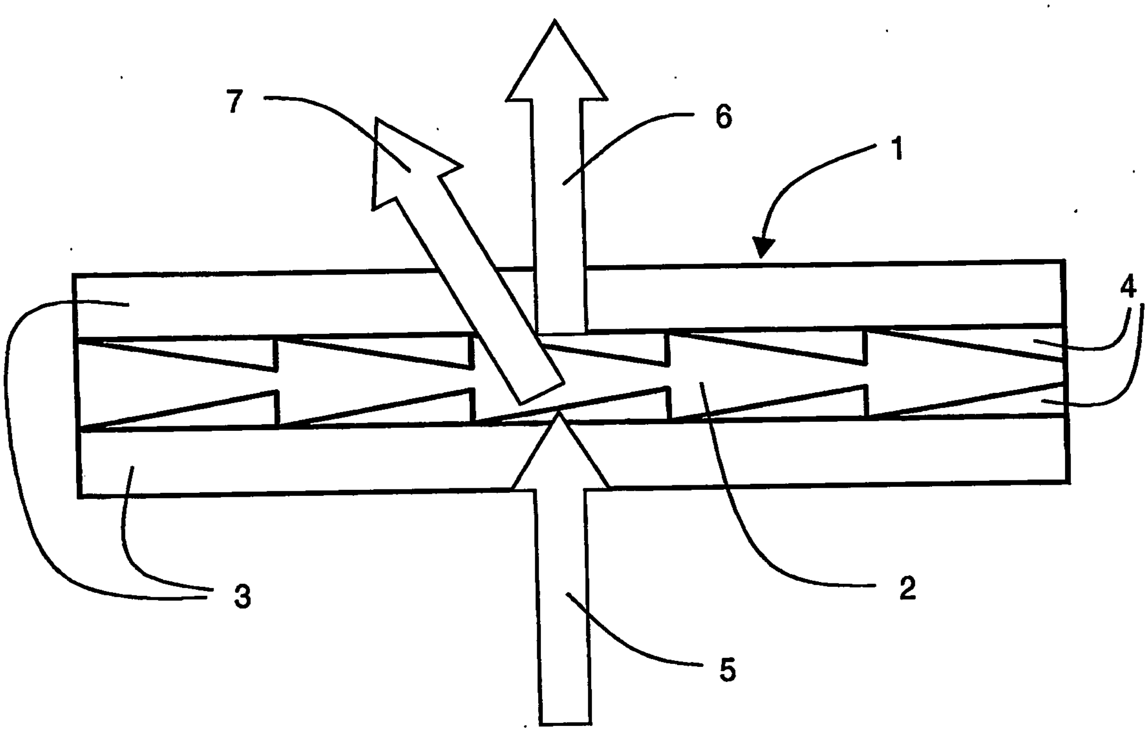

FIG.1

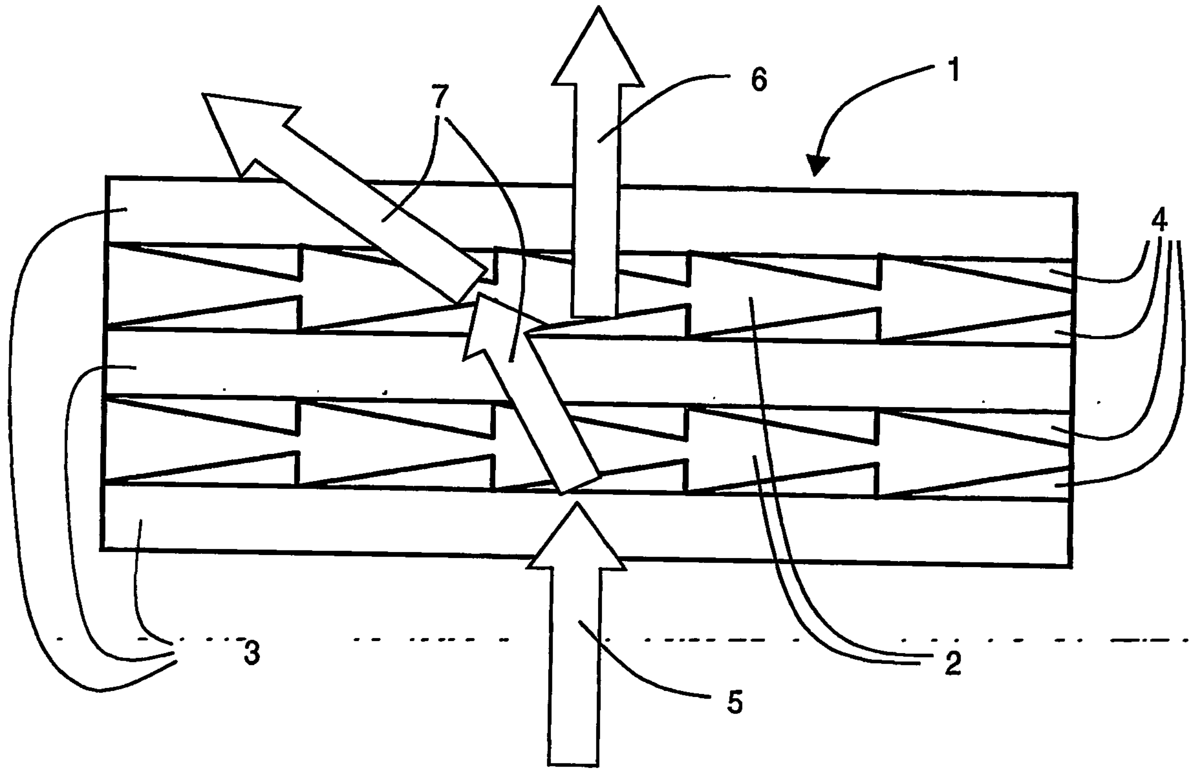

FIG.2

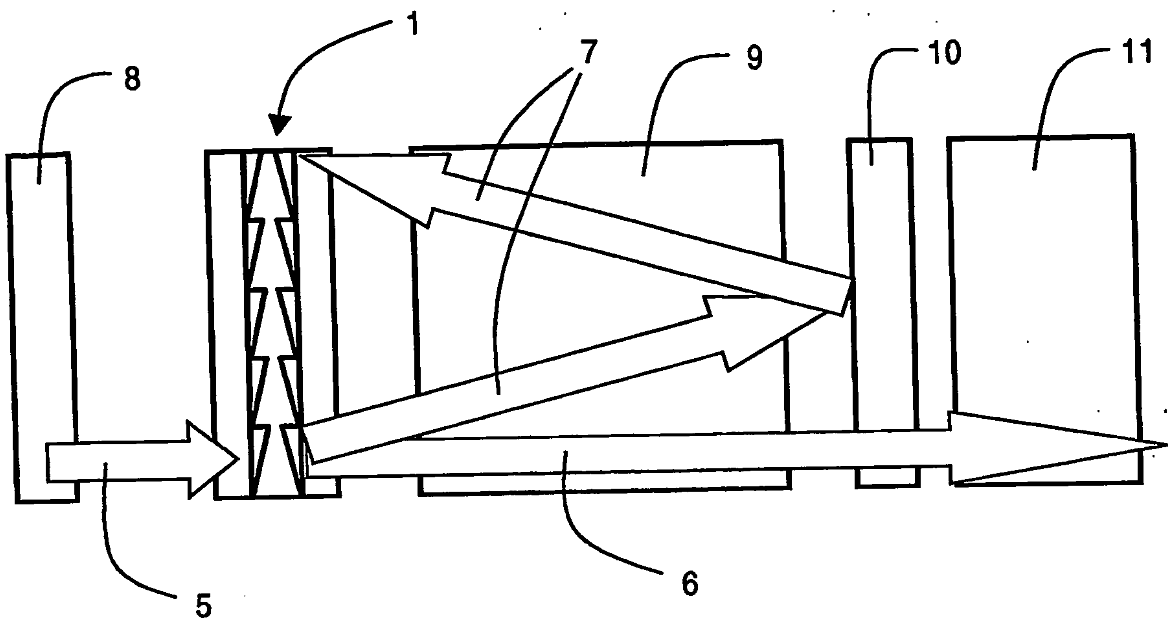

FIG.3

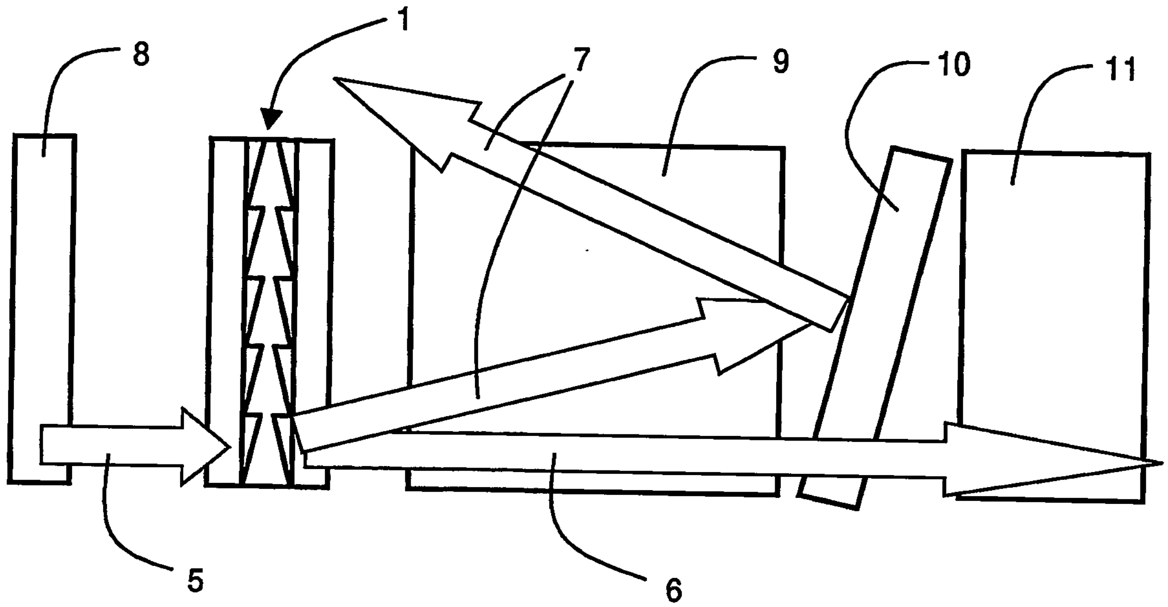

FIG.4